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⑤発明の名称　電子放出素子の製造方法

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明　細　書

1．発明の名称

電子放出素子の製造方法

2．特許請求の範囲

(1) 対向する電極間に設けられた電子放出材料の薄膜を、加熱雰囲気中で通電加熱処理を行い、高抵抗な電子放出部を形成することを特徴とする電子放出素子の製造方法。

(2) 加熱雰囲気がプレート状ヒーター、赤外線ヒーターまたは誘導加熱を使用して形成された雰囲気である特許請求の範囲第1項記載の電子放出素子の製造方法。

3．発明の詳細な説明

[産業上の利用分野]

本発明は電子放出素子の製造方法に関し、特に基板もしくはパネルを加熱後、赤外線ヒーター等の加熱手段を利用して形成した加熱雰囲気中で通電加熱によりフォーミングを行う電子放出素子の製造方法に関する。

[従来の技術]

従来、簡単な構造で電子の放出が得られる素子として、例えば、エム　アイ　エリンソン(M.I. Elinson)等によって発表された冷陰極素子が知られている。[ラジオ　エンジニアリング　エレクトロン　フィジィックス (Radio Eng. Electron. Phys.) 第10巻, 1290～1296頁, 1965年]

これは、基板上に形成された小面積の薄膜に、膜面に平行に電流を流すことにより、電子放出が生ずる現象を利用するもので、一般には表面伝導型放出素子と呼ばれている。

この表面伝導型放出素子としては、前記エリンソン等により開発されたSnO₂(Sb)薄膜を用いたもの、Au薄膜によるもの[ジー・ディトマー"スイン　ソリド　フィルムス" (G. Dittmer: "Thin Solid Films"), 9巻, 317頁, (1972年)]、ITO薄膜によるもの[エム　ハートウェル　アンド　シー　ジー　フォンスタッド"アイ　イー　イー　イー　トランス"　イー　ディー　コンフ (M. Hartwell and C. G. Fonstad: " IEEE

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Inventors: ~~Sakano~~ Banno et al.
Applicant: Canon Kabushiki Kaisha

SPECIFICATION

1. Title of the Invention

ELECTRON EMISSION ELEMENT MANUFACTURING METHOD

2. Claims

(1) An electron emission element manufacturing method characterized by the step of subjecting the thin film of an electron emission material interposed between confronting electrodes to energization and heating processing in a heated atmosphere to thereby form an electron emitting portion having a high resistance.

(2) An electron emission element manufacturing method according to claim 1, wherein the heated atmosphere is an atmosphere formed using a plate-like heater, an infrared heater or a high temperature vessel.

3. Detailed Description of the Invention

[Industrial Field of the Invention]

The present invention relates to an electron emission element manufacturing method, and more specifically, to an

electron emission element manufacturing method of carrying out forming by energizing and heating a substrate or a panel in a heated atmosphere formed making use of a heating means such as a high temperature vessel, an infrared heater and the like.

[Description of the Related Art]

Conventionally, there is known a cold cathode element reported by, for example, M. I. Elinson et al. (Radio Engineering Electron Phys. Vol. 10, pages 1290 - 1296, 1965) as an element which can obtain electron emission by a simple structure.

This is generally called a surface conductive type emission element which makes use of a phenomenon that electron emission is caused when a current flows to the thin film of a small area formed on a substrate in parallel with a film surface.

Reported as the surface conductive type emission element are an element using SnO_2(Sb) thin film developed by Elinson et al., an element using an Au thin film (G. Dittmer: "Thin Solid Films") Vol. 9, page 317, 1972), an element using an ITO thin film (M. Hertwell and C. G. Fonstad: "IEEE Trans. ED Conf.") page 519, 1975), an element using a carbon thin film (Hisashi Araki et al.: "Vacuum" Vol. 26, No. 1 page 22, 1983, and the like.

Fig. 3 shows a typical element arrangement of the

surface conductive type emission elements. In Fig. 3, numerals 1 and 2 denote electrodes for obtaining electrical connection, numeral 3 denotes a thin film formed of a electron emission material, numeral 4 denotes a substrate, and numeral 5 denotes an electron emission portion.

Conventionally, in these surface conductive type emission elements, an electron emission portion is previously formed by energization and heating processing called forming prior to the execution of electron emission. That is, the thin film 3 is energized by imposing a voltage between the electrodes 1 and 2. Then, an electron emission function is obtained by locally breaking, deforming or altering the thin film 3 with the Joule heat generated thereby and forming the electron emission portion 5 which is in an electrically high resistance state.

[Problems to be Solved by the Invention]

However, in the forming carried out only by the conventional energization and heating as described above, thermal stress is accumulated in a substrate or in the thin film of an electron emission material when it is heated, or it is cooled rapidly because an in-film current does not flow just after the forming is finished. Thus, the following problems are caused by the accumulated energy and the rapid cooling:

(1) the substrate is cracked in the forming because the

substrate is locally heated in the energization and heating;

(2) since the degree of change of the thin film caused by the energization and heating, for example, the degree of local breakage, deformation, alteration and the like is varied among a plurality of elements formed on the same substrate, there is a problem in the uniformity and reproducibility of the characteristics of the respective elements formed in the same substrate.

Because of the above problems, at present, the surface conductive type emission element is not positively used in industries regardless of the advantage thereof that an element structure is simple.

An object of the present invention, which was made to solve the above problems of the conventional example, is to provide a method of manufacturing an electron emission element capable of preventing the breakage of a substrate by subjecting the thin film of an electron emission material to energization and heating processing in a heated atmosphere and uniformly forming a plurality of elements in the same substrate with good reproducibility without the variation of quality.

[Means for Solving the Problems]

The present invention is an electron emission element manufacturing method which is characterized by the step of subjecting the thin film of an electron emission material

interposed between confronting electrodes to energization and heating processing in a heated atmosphere to thereby form an electron emission element having a high resistance.

In the present invention, it is preferable to carry out the energization and heating processing in the heated atmosphere which is an atmosphere formed using a plate-like heater, an infrared heater, a high temperature vessel and the like and to form an electron emitting portion having a high resistance.

[Operation]

The electron emission element manufacturing method of the present invention is arranged such that the thin film of an electron emission material interposed between confronting electrodes is subjected to energization and heating processing in a heated atmosphere to thereby form an electron emission element having a high resistance. Heating and cooling are carried out stepwise so that the thermal stress caused to a substrate or to the thin film of a electron emission material is moderated when it is heated, whereby the breakage of the substrate can be prevented and a plurality of electron emission elements having uniformity can be manufactured in the same substrate with good reproducibility without the variation of quality.

[Embodiment]

The present invention will be described below in detail

with reference to an embodiment shown in drawings.

Fig. 1 is a view explaining the embodiment of the present invention. In the figure, numeral 14 denotes a substrate having an insulating property, numeral 13 denotes a thin film formed of an electron emission material, numerals 11 and 12 denote electrodes for obtaining electric connection, and numeral 15 denotes a plate-like heater for heating an overall substrate or an overall panel.

In Fig. 1, the method of manufacturing the electron emission element of the present invention is arranged such that, first, a thin film, which is composed of an electron emission material of various semiconductors, for example, metal oxides such as SnO_2, In_2O_3, PbO, etc., metals such as Au, Ag, Pt, etc., carbon and the like, is formed on the rinsed glass substrate 14 by vapor deposition or sputtering and then the thin film 13 composed of the electron emission material and having a neck portion, where an electron emission portion is formed, is formed by photolithography.

Next, the electrodes 11 and 12 for obtaining the electric connection to the electron emitting portion are formed on the thin film 13 using an ordinary conductive material such as Ni, Pt, Al, Cu, Au or the like.

The thus formed element is heated by the ordinary plate-like heater 15 in air or in a vacuum vessel to an arbitrary temperature ranging from a room temperature to a

maximum temperature which is the point at which the substrate 14 is distorted or the melting point of the electron emission material of the thin film 13 so as to generate a heated atmosphere. Then, a voltage is imposed between the electrodes 11 and 12 and the thin film 13 of the electron emission material is subjected to energization and heating processing so that the thin film 13 is locally broken, deformed or altered, thereby forming an electron emitting portion having a high electric resistance.

At the time, in the forming, which was carried out by means of only the energization and heating processing without using the heated atmosphere similarly to the conventional method, the substrate was cracked and the characteristics of the element could not be measured. However, according to the embodiment, the forming could be carried out without the occurrence of crack in the substrate.

Next, Fig. 2 shows a view explaining an electron emission element manufacturing apparatus in which the heating atmosphere is formed using an infrared heater. In the figure, numeral 21 denotes an electron emission element, numeral 22 denotes a power supply unit for carrying out the energization and heating, numeral 23 denotes a bell-jar, numeral 24 denotes a vacuum and exhaust unit and numeral 25 denotes the infrared heater for heating the electron emission element. In Fig. 2, heating is carried out using

the infrared heater in vacuum and the thin film of the electron emission material is subjected to the energization and heating processing in the heated atmosphere likewise in the Fig. 1, whereby an electron emitting portion having a high resistance can be formed.

Further, according to the electron emission element manufacturing method of the present invention, the electron emitting portion having the high resistance can be formed by carrying out the energization and heating processing in the heated atmosphere using a high temperature vessel.

In any of the above methods, the forming can be carried out without the occurrence of cracking of the substrate likewise the embodiment shown in Fig. 1.

Further, according to the present invention, even if the same substrate has a plurality of electron emission elements, forming having uniformity and reproducibility can be carried out in the same substrate because the substrate is kept at the same temperature as a whole.

Further, the electron emission element can be subjected to the forming after it is arranged as a panel in a display tube. At the time, the breakage of the element can be prevented when it is arrange as the panel.

As shown in the embodiment, in the forming of the present invention, the thermal stress caused to the substrate and the thin film in the energization and heating

processing can be moderated by performing heating and cooling stepwise by avoiding rapid heating when the substrate and the thin film are heated in the heated atmosphere and avoiding rapid cooling thereof in a subsequent cooling step. Accordingly, the breakage of the substrate can be prevented and the forming having the uniformity and reproducibility can be can be carried out to a plurality of elements in the same substrate.

[Advantages]

As described above, the electron emission element manufacturing method of the present invention has the following excellent advantages by carrying out the forming by means of the energization and heating processing in the heated atmosphere:

(1) the breakage of a substrate can be prevented;

(2) a plurality of uniform elements having reproducibility can be formed in the same substrate without the variation of quality; and

(3) a degree of freedom can be increased in the design of elements and in the design of their manufacturing processes.

4. Brief Description of the Drawings

Fig. 1 is a view explaining an embodiment of an electron emission element manufacturing method of the present invention, Fig. 2 is a view explaining an electron

emission element manufacturing method by which a heated atmosphere is formed using an infrared heater, and Fig. 3 is a view explaining conventional art.

1, 2, 11, 12 … electrode

3, 13 … thin film

4, 14 … substrate

5 … electron emitting portion

15 … plate-like heater

21 … electron emission element

22 … power supply unit

23 … bell-jar

24 … vacuum and exhaust unit

25 … infrared heater

24—真空排気系装置
25—赤外線ヒーター

出願人 キヤノン株式会社
代理人 渡辺徳廣

FIG. 3

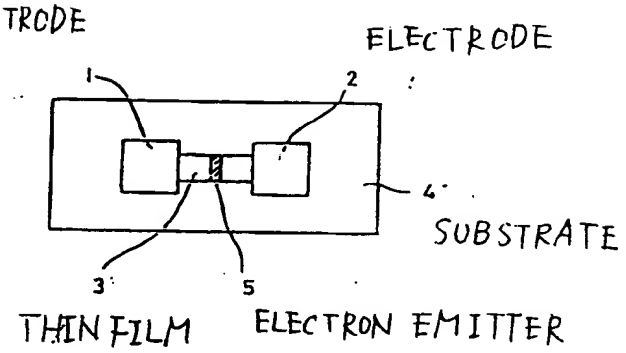

FIG. 1

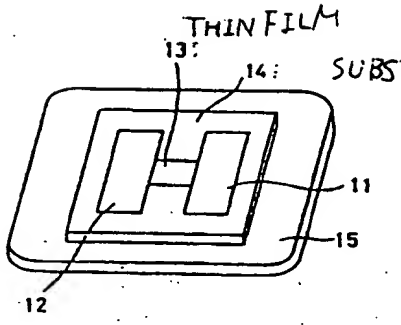

FIG. 2